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SOYBEAN CYST NEMATODE - BIOLOGY AND MANAGEMENT

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Soybean cyst nematode, *Heterodera glycines*, is a small, unsegmented plant-parasitic roundworm that attacks the roots of soybeans. Many plant-parasitic nematodes are believed to be endemic or native to the United States, but soybean cyst nematode is thought to have been introduced from Japan. Soybean cyst nematode was first discovered in the United States in 1954 in North Carolina (Winstead et al., 1955), and has since spread to 26 additional states in the Southeast and Midwest (Noel, 1992). It was first discovered in Iowa in Winnebago County in 1978. In 1995, soybean cyst nematode was identified for the first time in Clinton and Scott Counties. Currently, the nematode is known to exist in 69 Iowa counties and is suspected to be present in many other counties as well.

Symptoms

Symptoms of soybean cyst nematode damage can be classified into two categories, above-ground and below-ground. Above-ground symptoms of soybean cyst nematode damage do not appear consistently and may be absent for several years following introduction of the nematode into a field. The above-ground symptoms, when present, may appear in circular or oblong patterns which vary in size or may be more generalized across much or all of the field. When symptoms appear in a localized spot, the most severe damage usually occurs in the center of the spot. Above-ground symptoms initially may appear near a gate or entrance to a field where farm machinery enters or along a fence line where wind-blown soil tends to accumulate.

Above-ground Symptoms

When above-ground symptoms appear, they are not unique and can be mistaken for damage due to compaction, iron deficiency chlorosis, other nutrient deficiencies, drought stress, herbicide injury, or other plant diseases. Often, soybean injury and yield loss due to soybean cyst nematode have probably gone undetected for several years because of absence of above-ground symptoms or misdiagnosis of these nondescript symptoms.

The first obvious symptom of soybean cyst nematode injury to soybeans may be the appearance of stunted, yellowed, less vigorous plants. Plants growing in heavily infested soils may remain stunted throughout the growing season. Additionally, rows of soybeans grown in infested fields often are slow to close or fill in with foliage.

Yellowing of soybeans due to soybean cyst nematode damage is often confused with iron deficiency chlorosis, particularly in areas with high pH soils where iron deficiency is a problem. However, there are differences between the symptoms of the two problems. Iron deficiency chlorosis symptoms will appear early in the growing season, usually in early June. Yellowing

due to soybean cyst nematode damage will occur later in the season, usually in July and August. Furthermore, yellowing due to iron deficiency chlorosis primarily affects the areas between the veins of the upper leaves while soybean cyst nematode yellowing usually begins at the leaf margins of leaves over the entire plant. Iron deficiency chlorosis and soybean cyst nematode may occur in the same field with symptoms of both occurring on the same plant.

As mentioned earlier, above-ground symptoms of soybean cyst nematode damage do not always occur consistently. Symptoms can range from severe to nonexistent. The intensity of the symptoms is influenced by the age and vigor of the soybean plants, the nematode population density in the soil, soil fertility and moisture levels, and other environmental conditions. Soybean cyst nematode damage usually is more severe in light, sandy soils but will occur readily in all types of soil.

One can not rely upon above-ground symptoms for identification of soybean cyst nematode infestations. If soybean yields in a particular field have leveled off or decreased for no apparent reason or if soybean cyst nematode has been confirmed on nearby land, more thorough examination of plants for below-ground symptoms and a soil analysis are needed.

Below-ground Symptoms

Most below-ground symptoms of soybean cyst nematode injury are not unique. Roots infected with the nematode are dwarfed or stunted. Soybean cyst nematode also decreases the number of nitrogen-fixing nodules on the roots. Furthermore, infection of roots by soybean cyst nematode may make the roots more susceptible to infection by other soil-borne plant pathogens. Often, it is difficult to recognize roots as being stunted and having fewer nodules unless some uninfected soybean roots also are available for side-by-side comparison.

The only unique sign of soybean cyst nematode infection is the presence of adult female nematodes and cysts on the soybean roots. Females and cysts appear as tiny, lemon-shaped objects which are initially white but turn yellow, then tan to brown as they mature. The females and cysts can be seen on infected roots with the unaided eye, although observation with a magnifying glass usually is much easier. The females and cysts are about the size of a period at the end of a sentence and are much smaller than nitrogen-fixing nodules. Roots should be carefully dug, not pulled, from the soil to observe the nematodes on the roots, otherwise many of the females and cysts may become dislodged. Observation of the nematodes on the roots of infected soybean plants is the ONLY accurate way to diagnose soybean cyst nematode infestations in the field. In most years, such diagnoses can be performed beginning four to six weeks after planting and continuing through September in Iowa.

Life Cycle of Soybean Cyst Nematode

The soybean cyst nematode life cycle has three major stages: egg, juvenile, and adult. The life cycle can be completed in 24 to 30 days under optimum conditions in the summer. Consequently, three to four generations per growing season are possible in the Midwest. Worm-shaped soybean cyst nematode juveniles hatch from eggs in the soil when adequate temperature

and moisture levels occur in the spring (Schmitt and Riggs, 1989). These juveniles are the only life stage of the nematode capable of infecting soybean roots. Hatched juveniles that do not penetrate host roots and begin feeding will die from starvation, predation, or parasitism within several days to a few weeks.

After penetrating the soybean roots, juveniles move through the root until they contact the vascular tissue. There they cease moving, lose most of the muscles in their bodies, and begin to feed. In order to feed, the nematodes inject secretions which modify root cells and transform them into specialized feeding sites called syncytia.

As the nematodes feed they swell, and eventually the female nematodes become so swollen that they break out through the root tissue and are exposed on the surface of the root. Male nematodes, which are not swollen as adults, migrate out of the roots into the soil and fertilize the lemon-shaped adult females on the roots. After fertilization, males eventually die whereas females remain attached to the roots and continue to feed. The swollen females begin to produce eggs, initially in a mass or egg sac outside the body and later within the body cavity of the female. The entire body cavity of the adult female eventually becomes filled with eggs, and the female dies. It is the egg-filled body of the dead female that is referred to as the cyst. Cysts will eventually dislodge from the roots and become free in the soil. The walls of the cyst become very tough and provide excellent protection for the 200 to 400 eggs contained within. Soybean cyst nematode eggs survive within the cyst until conditions become proper for hatching. Although many of the eggs may hatch within the first year, many also will survive within the cysts for many years.

Spread of Soybean Cyst Nematode

Soybean cyst nematode can move through the soil only a few inches per year on its own power. However, it can be spread great distances in a variety of ways. Generally, anything that moves even small amounts of soil is capable of disseminating soybean cyst nematode. Spread can occur by soil moved by farm machinery, vehicles and tools, wind, water, animals, and farm workers. Seed-sized clumps of soil, called soil peds, often contaminate seed harvested from plants grown on infested land. Soybean cyst nematode can be spread if this seed is planted in noninfested fields. There is even evidence that cysts of soybean cyst nematode can be spread by birds. Obviously, only some avenues of spread of this nematode can be prevented. Recent flooding in the Midwest undoubtedly has expanded the distribution of soybean cyst nematode throughout the region.

Management of Soybean Cyst Nematode

For all practical purposes, soybean cyst nematode can never be eliminated from soil once it is present. However, there are things that can be done to manage the nematode in order to maximize yields and minimize reproduction of the nematode. Management practices for soybean cyst nematode fall into five categories.

1. Maintenance of plant health

Plants that have adequate moisture and fertility are better able to withstand infection by soybean cyst nematode. Consequently, maintaining proper soil fertility and pH levels in land infested with soybean cyst nematode is more critical to maximizing yield than when land is noninfested. Also, it is important to control other plant diseases as well as insect and weed pests that weaken the plants and make them more susceptible to the yield-suppressing effect of the nematode.

2. Sanitation

Common sense sanitation practices can be very effective in preventing or delaying the spread of soybean cyst nematode to noninfested land. If only certain fields on a farm are infested, planting and cultivating of infested land should be done only after noninfested fields have been worked. Equipment should be thoroughly cleaned with high pressure water or steam, if available, after working in infested fields. Also, one should not use seed grown on infested land for planting unless the seed has been properly cleaned. As mentioned previously, soybean cyst nematode may be spread in the seed-sized soil peds associated with the seed.

3. Host resistance

Resistant soybean varieties are the most effective tool available for management of soybean cyst nematode. By planting resistant soybeans in infested soil, reproduction of the nematode is suppressed. Most soybean cyst nematode juveniles will be unable to feed and reproduce on the roots of resistant varieties, but a few nematodes will survive and reproduce. Some resistant varieties may yield slightly less than susceptible varieties in noninfested fields, but will yield significantly better in fields infested with soybean cyst nematode. The performance of resistant varieties on noninfested land is constantly being improved. In the past, there were few resistant varieties available for Iowa, but in recent years many public and private varieties have been released. Virtually all soybean cyst nematode resistant soybean varieties available in Iowa obtained resistance from one of two soybean breeding lines, 'Peking' or 'PI88788'.

Although use of resistant varieties is the most effective management strategy for soybean cyst nematode, RESISTANT VARIETIES SHOULD NEVER BE PLANTED YEAR AFTER YEAR. If resistant varieties are planted for several years in a row, eventually a population (or race) of soybean cyst nematode may develop which is capable of reproducing on the resistant varieties. Growers are encouraged to alternate use of soybean varieties with different sources of soybean cyst nematode resistance. Furthermore, it is recommended that a susceptible soybean variety be grown once after all types of available resistance have been used to offset the effect of growing the resistant soybean varieties. Following is a recommended six-year rotation scheme using the two types of soybean resistance widely available in Iowa in conjunction with susceptible soybean varieties and nonhost crops for integrated management of soybean cyst nematode. Growers should consult county extension personnel and seed company representatives for information on

suitable resistant soybean varieties and their sources of SCN resistance or to further discuss other aspects of effective crop rotation schemes.

- 1st year - Nonhost crop
- 2nd year - 'PI88788' Resistant soybean
- 3rd year - Nonhost crop
- 4th year - 'Peking' Resistant soybean
- 5th year - Nonhost crop
- 6th year - Tolerant (high-yielding), Susceptible soybean

4. Nonhost crops

Soybean cyst nematode is an obligate parasite and is unable to develop and reproduce in the absence of host roots. Consequently, soybean cyst nematode population densities decline during any year that nonhost crops are grown. Alfalfa, corn, and oat are common nonhost crops grown in Iowa, and soybean cyst nematode densities decline similarly when infested soils are planted with these three crops.

5. Nematicides

There are several nematicides which are labeled for use against soybean cyst nematode. These materials often do not give season long control. When applied at planting, the effect of the nematicides may last long enough to provide an economic yield benefit. By the end of the growing season, however, soybean cyst nematode numbers may be as high or higher than at planting. No nematicide will kill all soybean cyst nematodes in the soil.

The performance of the nematicide will depend on soil conditions, temperatures, and rainfall. A yield benefit is not guaranteed, and nematicides are expensive. Consequently, growers are advised to consider economic, environmental, and personal health factors before utilizing nematicides for management of soybean cyst nematode.

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